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ABSTRACT

Research has helped to identify the fundamental skills that should be developed in an activity-based science program: observing, describing, comparing, classifying, measuring, using numbers, interpreting evidence, inferring, predicting, and experimenting. A teaching/learning inservice workshop was designed to help elementary school teachers replace traditional science instruction format (reading and memorizing science concepts) with a format emphasizing the above-listed processes. Participating teachers were instructed in the learning theories of Piaget and the developmental thinking of their students. The workshop provided the teachers with experiences to help them develop classroom environments conducive to implementation of an activity-based science program. A teaching procedure, the "learning cycle," actively involved them in experimentation, discussion of scientific methods, and scientific record keeping and data analysis. The workshop experiences also prepared the teachers to match their teaching procedures with the level of intellectual development of their students. The ultimate goal of the teaching/learning science inservice workshop was the intellectual development of the students through appropriate teaching strategies. Three tables containing study data are appended. (JD)

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WILL INSERVICE EDUCATION ALLEVIATE THE CURRENT PROBLEMS IN SCIENCE EDUCATION?

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ABSTRACT

There exists problems in science education today which will be tomorrow's crises in science education. Research with inservice education demonstrates the teacher's role to ameliorate these problems. The purpose of this research was to measure the effects of theory based inservice education on learning, educational philosophy, and teaching strategies of inservice science teachers.

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WILL INSERVICE EDUCATION ALLEVIATE THE CURRENT PROBLEMS IN SCIENCE EDUCATION?

Introduction

Achievement test scores in science have steadily declined since the early 1960s, and this decline is most apparent at the higher grade levels (Jones, 1981). According to the National Science Board Commission (1983), four factors contribute to this decline: teachers, classrooms, curricula, and instructional approach. An increasing number of graduating teachers lack the necessary experiences in science education to motivate their students or to provide an atmosphere conducive to doing science. A large majority of today's classrooms emphasize basic computational skills only, never offering application, either because of obsolete laboratory equipment or lack of knowledge in the use of existing equipment. Finally, the instructional approach presented to today's students seldom matches the teaching procedures with the level of intellectual development of the learner.

Research has shown how students learn science concepts and the resulting evidence suggests that the level of thought is changed when students are exposed to activity oriented experiences (Schneider & Renner, 1980; Wollman & Lawson, 1978; Karplus, 1977). For example, inquiry teaching procedures can increase IQ, achievement level, and intellectual development of students in science (Lombard, 1982; Marek & Renner, 1979). As Hausman has stated, "the basic processes used in science - observing, describing, comparing, classifying, measuring, using numbers, interpreting evidence, inferring, predicting, experimenting - are such fundamental skills that they should be developed during the formative years in an activity-based science program" (Hausman, 1976).

Research has helped to identify the current aforementioned problems in science education, and now educators must begin to solve the problems. If we are to apply the evidence presented by educators to correct these problems, we must first change the

"traditional teaching" format present in science classrooms today. How can we replace this traditional teaching format, which basically consists of reading and memorizing science concepts, with a format that emphasizes the processes an individual must go through in order to do science? An obvious answer lies with teachers gaining experience with the teaching procedures involved in an activity oriented program and, furthermore, educating teachers to match this instructional approach with the level of intellectual development of their students.

Inservice programs for teachers have been conducted which matches teaching procedure and learning theory (Lombard, 1982). The purpose of this research was to measure the effects of such inservice education on educational philosophy and teaching strategies of inservice science teachers.

The Inservice Workshop

In the fall of 1982 a teaching/learning science inservice workshop was presented to a group of thirteen elementary teachers. The workshop was conducted in two-hour sessions for four consecutive weeks. The group was instructed in the learning theories of Piaget and the developmental thinking processes of their students. They then experienced a teaching procedure developed from this theory of constructing, or developing, knowledge. This teaching procedure was the "learning cycle" and consisted of three phases which actively involved the teachers with experimentation, discussions, and record keeping. During the first phase--Exploration--data were gathered through a series of activities such as experimenting, interpreting, predicting, measuring, and model building. The teachers were provided with all of the essential materials for conducting the experiments. The data were organized into charts, tables, or graphs and discussed by the whole class. The idea or concept being studied was then identified from the data during this second phase of the learning cycle--Conceptual Invention. Appropriate scientific language and terminology were provided during this phase. After the conceptual invention, the idea was applied and expanded in another series of activities--the Expansion. In other words

the concept was applied to other areas and built upon through further experimenting, interpreting, predicting, measuring and model building.

Workshop Evaluation

After the inservice workshop, the teachers were asked to reply to a workshop evaluation instrument. Their responses indicated the extent to which the information and experiences provided in the workshop had altered their thinking and teaching. The data also indicated any factors that either facilitated or hindered their ability to utilize the information and experiences of the inservice workshop. Past and present levels of implementation practices were measured and compared by having participants reply three months after the inservice experience and again one year after the inservice workshop (Tables II and III).

A 26-item instrument, titled "Teaching/Learning Science Inservice Workshop Evaluation Questionnaire," was modified from an instrument developed and validated by Lombard (1982). The first section provided data for the biographical profile of the teachers in the study (Table I). The remainder of the instrument was a five point response scale designed to ascertain the degree of implementation of the learning cycle into the classroom (Table II) and the degree of application to the laboratory, textbook and tests (Table III). Summaries of the results from both administrations of this workshop evaluation questionnaire are discussed together in the Results and Interpretations.

Results and Interpretations

The inservice teachers participating in this study (Table I) were females with three to 25 years of teaching experience and 23 percent of the participants had a master's degree. Teaching assignments ranged from kindergarten through the eighth grade with an average class size of 25 pupils.

Results from both workshop evaluation summaries (Table II) demonstrated that the teachers agreed they had become more aware of their student's reasoning processes and

with the approach presented in the workshop. All of the teachers of this study agreed that the administrators at their school supported changes that incorporated curricula emphasizing reasoning development. Job security was not considered to be a factor inhibiting usage of information presented in the workshop, and all teachers responded positively when asked about teacher input concerning inservice programs in their school system. The teachers agreed that they should plan or teach some of their classes differently, but most replied that they presently had insufficient planning time to make innovations in their science teaching both initially and again after a one year time span.

Other results from the workshop evaluation summaries (Table III) demonstrated that teachers utilized workshop experiences and information to a great extent when presenting new concepts and introducing new topics. Laboratory design and test questions were also modified by the teachers of this study in order to match the instructional approach with the student's level of intellectual development.

The "z" test for two proportions was used as the statistical analysis of the data to indicate application of workshop information and practices to the classroom. The "z" score of 2.08 was significant at .01 level and indicated a higher level of usage of workshop practices and information at the one year evaluation period. An inference that could be drawn from these data is that a higher confidence level of the teacher was acquired with continued usage and practice of workshop experiences in the classroom.

Conclusions

The teaching/learning science inservice workshop provided the experiences, needed by the teachers of this study, to develop classroom environments conducive to doing science; science as a process--the learning cycle. The workshop experiences also prepared these teachers to match their teaching procedures with the level of intellectual development of their students. The role of the teacher must include these responsibilities and it is the teacher's role which must be assessed if we are to ameliorate the many problems present in science education today. The workshop of this study addressed these primary responsibilities of the teacher.

One of the most important measures of an inservice program is its ultimate effect on the students, and inservice programs are attempting to help teachers perform their teaching assignments more effectively (Bethel, 1982). The ultimate goal of the teaching/learning science inservice workshop of this study is intellectual development of the student through appropriate teaching strategies. Through education of the teacher, this workshop has had a direct influence on the classroom, the curricula, and the instructional approach as demonstrated by application in the classroom ranging from 53 to 92 percent (Table III).

As a pilot study this research provided fundamental data essential for a comprehensive examination, to be conducted by these investigators, on the effectiveness of inservice education. Subsequent research on inservice effectiveness will encompass a much larger population of inservice teachers. Consideration will again be given to affecting teaching strategies through inservice education.

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TABLE I - DEMOGRAPHIC DATA ABOUT THE RESPONDENTS

Question administered to inservice teachers	Response			
1. Hours of workshop attendance	3-4 hours	5-6 hours	More than 6	
	0%	31%	69%	
2. Teaching level	K-3	4-6	7-9	10-12
	77%	15%	7%	0%
3. Years of teaching experience	0-3	4-7	8-15	16-25
	8%	8%	46%	38%
4. Sex	Female		Male	
	100%		0%	
5. Major teaching responsibility by subject area	Self-contained	Math & Reading	Math & Science	
	69%	23%	7%	
6. Highest degree earned	Bachelor's	Master's	Doctorate	Other
	77%	23%	0%	0%
7. Approximate number of students per class	15	20	25	and up
	7%	31%	62%	0%
8. Description of participation	Voluntary	Mandatory	Released time	Interest Promoted Attendance
	34%	2%	32%	32%

TABLE II - RESULTS OF THE "TEACHING/LEARNING SCIENCE INSERVICE WORKSHOP"

Question administered to inservice teachers	Strongly agree		Agree		Disagree		Strongly disagree		Irrelevant or unsure	
	3 mos.	1 yr	3 mos.	1 yr	3 mos.	1 yr	3 mos.	1 yr	3 mos.	1 yr
1. As a result of this workshop, I have become more aware of the reasoning processes of my students.	23%	7%	77%	93%	0%	0%	0%	0%	0%	0%
2. The "learning cycle" as described in the workshop can be an effective way to teach science.	46%	57%	54%	43%	0%	0%	0%	0%	0%	0%
3. I was involved in the decision to have the Teaching/Learning Science Workshop at my school.	23%	62%	54%	38%	7%	0%	0%	0%	15%	0%
4. The teachers generally have input into making decisions about inservice programs in my school.	23%	43%	77%	50%	0%	7%	0%	0%	0%	0%
5. The workshop addressed my individual concerns as a teacher.	0%	0%	85%	79%	15%	14%	0%	7%	0%	0%
6. I had the opportunity to actively participate during the workshop.	15%	14%	85%	86%	0%	0%	0%	0%	0%	0%
7. I felt I could not incorporate the ideas of the workshop into my teaching.	0%	0%	0%	15%	69%	62%	31%	23%	0%	0%
8. The workshop provided the opportunity to work and discuss with other participants.	15%	21%	85%	79%	0%	0%	0%	0%	0%	0%

TABLE II CONTINUED:	Strongly agree		Agree		Disagree		Strongly disagree		Irrelevant or unsure	
	3 mos	1 yr	3 mos	1 yr	3 mos	1 yr	3 mos	1 yr	3 mos	1 yr
9. I feel I should plan or teach some of my classes differently as a result of the workshop.	8%	7%	84%	86%	8%	0%	0%	7%	0%	0%
10. The ideas of the workshop did not fit with what I already believed about teaching and learning.	0%	0%	0%	15%	62%	54%	38%	31%	0%	0%
11. After the workshop , I agreed with the approach to teaching and learning presented in the workshop.	8%	14%	92%	86%	0%	0%	0%		0%	0%
12. I feel that some change in my teaching has occurred as a result of participating in this workshop.	0%	14%	100%	79%	0%	7%	0%	0%	0%	0%
13. The morale in my school is high.	62%	47%	38%	53%	0%	0%	0%	0%	0%	0%
14. My admin'stration does not support changes I make in the direc:on of increased emphasis on reasoning development.	0%	0%	0%	0%	38%	57%	62%	43%	0%	0%
15. I need more planning time during school hours if I am going to make any innovations in my science teaching.	15%	8%	46%	22%	15%	62%	15%	0%	9%	8%
16. The issue of job security prevents me from being as innovative as I would like.	0%	0%	0%	7%	38%	57%	62%	36%	0%	0%

TABLE III - APPLICATION OF IDEAS FROM THE WORKSHOP

Questions administered to inservice teachers	Response									
To what extent have you applied the ideas of the workshop in the following areas:	Not at all		Very little		Moderately		Considerably		A great deal	
	3 mos	1 yr	3 mos	1 yr	3 mos	1 yr	3 mos	1 yr	3 mos	1 yr
a. Laboratory Design	22%	38%	12%	9%	44%	38%	22%	15%	0%	0%
b. Introducing New Topics	9%	0%	0%	7%	58%	64%	33%	29%	0%	0%
c. Tests	43%	25%	0%	17%	43%	25%	14%	33%	0%	0%
d. Presentation of Concepts	8%	0%	0%	0%	50%	57%	42%	36%	0%	7%